

JOB III. AMERICAN SHAD HATCHERY OPERATIONS, 2010

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INTRODUCTION

The Pennsylvania Fish and Boat Commission has operated the Van Dyke Research Station for Anadromous Fishes since 1976 as part of an effort to restore diadromous fishes to the Susquehanna River Basin. The objectives of the Van Dyke Station were to research culture techniques for American shad and to rear juveniles for release into the Juniata and Susquehanna Rivers. The program goal was to develop a stock of shad imprinted to the Susquehanna drainage, which will subsequently return to the river as spawning adults. With the completion of York Haven Dam fish passage facilities in 2000, upstream hydroelectric project owners were no longer responsible for funding the hatchery effort. Funding was provided by the Pennsylvania Fish and Boat Commission.

In 2003, a new effort in migratory fish restoration was undertaken. Adult hickory shad (*Alosa mediocris*) were collected and tank-spawned as part of the initial efforts to culture, release and restore runs of hickory shad to the Susquehanna and Delaware River basins. No hickory shad culture occurred in 2010 due to budget constraints.

As in previous years, production goals for American shad for 2010 were to stock 10-20 million American shad larvae. All Van Dyke hatchery-reared American shad larvae

were marked by immersion in tetracycline bath treatments in order to distinguish hatchery-reared shad from those produced by natural spawning of wild adults. All eggs received at Van Dyke were disinfected to prevent the spread of infectious diseases from out-of-basin sources.

EGG SHIPMENTS

American shad

A total of 29.8 million American shad eggs (576 L) were received in 34 shipments in 2010 (Table 1). This was the highest quantity of eggs received since 2003 (Table 2, Figure 1). Overall American shad egg viability (which we define as the percentage which ultimately hatches) was 32%.

Seventeen Potomac River egg shipments (17.8 million eggs) were received from April 10 to May 6, 2010. Overall viability was 38%. This is by far the most eggs collected from the Potomac since 2006, when egg collection began on that river.

Delaware River egg shipments were received from May 17 to June 1. A total of nine shipments were received (4.6 million eggs) with a viability of 38%. This is slightly more than the average egg-take from 1996 to 2009 (Table 4, Figure 1). An early spring and other commitments hampered egg collections on the Delaware.

American shad eggs were also obtained from a tank-spawning effort at Conowingo Dam, operated by Normandeau Associates. Pre-spawn adult American shad were obtained from the West Fish Lift at Conowingo Dam. In most trials, shad were injected with hormones and allowed to spawn naturally. Two trials were experimental controls in which shad were not injected with hormones. Both controls were unsuccessful at

producing eggs. The tank-spawn array at Conowingo uses water pumped directly from the river and is subject to natural fluctuations in water temperature. Ability to control temperature in the tank (gradual warming to optimal temperature) is thought to be critical for successful tank-spawning without hormones (Jeff Evans, NC Wildlife Resource Commission, personal communication).

In hormone-injected trials, 7.3 million eggs, in eight shipments, were delivered to the Van Dyke Hatchery, with a viability of 16%. This has become a consistent source of eggs for the restoration program, but viability has been low, ranging from 9% to 33%.

No eggs were collected from the Hudson River in 2010 due to concerns over declines in the Hudson River stock. The loss of the Hudson River as an egg source is unfortunate because of its consistent production of high quality eggs. Egg production from the Potomac River has been consistently below the historical production from the Hudson River and it has become apparent that additional or expanded sources of eggs will be required to meet the goal of 10-15 million larvae stocked.

SURVIVAL

Survival of individual tanks followed patterns similar to those observed in the past in that the majority of the tanks experienced their highest mortality after nine days of age (Figure 2). Overall survival of American shad larvae was 67% compared to a range of 19% to 94% for the period 1984 through 2009. No tanks suffered complete mortality. The fluidized bed system installed in 2008 worked extremely well and pH of the fish culture water ranged from 7.0 to 7.6 with a mean of 7.3. Daily monitoring of gas saturation and adjustment of the oxygen injection system maintained nitrogen, oxygen

and total gas saturation at acceptable levels. Oxygen saturation averaged 104.3% with a maximum of 131.2%. The high value occurred a few days after the initial egg shipment was received and was quickly corrected before any hatching occurred. Excluding the high value, oxygen saturation averaged 103.8%. Nitrogen saturation averaged 101.5% with a maximum of 104.4%. Total gas saturation averaged 102.3% with a maximum of 103.9%. As a result, no incidents of gas bubble disease occurred. Larvae stocked in 2010 appeared active and robust.

Tanks with higher than normal mortalities (Figure 2) included tanks F41 (26d survival 40%), G11 (27d survival 45%), G21 (26 d survival 43%), and B22 (17 d survival 34%). These tanks were all reared in the second half of the season. The cause of these higher than normal mortalities is unknown. The mortality experienced in 2010 was average based on the overall survival of 67% compared to an average of 64% since hatchery operations began (Table 2).

LARVAL PRODUCTION

Production and stocking of American shad larvae, summarized in Tables 2, 3, and 4, totaled 5.4 million. A total of 2.9 million was released in the Juniata River, 442 thousand in the Susquehanna River at Liverpool, 186 thousand in Conodoguinet Creek, 217 thousand in the Conestoga River, 198 thousand in Swatara Creek, 179 thousand in West Conewago Creek, 115 thousand in the North Branch Susquehanna River in Pennsylvania, 400 thousand in the West Branch Susquehanna River and 100,000 in Bald Eagle Creek. Due to an inability to test and certify that the larvae were VHS free, no larvae were stocked in the Potomac River or New York waters of the Susquehanna River.

For the first time in several years, the Juniata River was low and clear enough to stock large numbers of larvae there.

Delaware River egg collections were good due to stable weather conditions and no high water events; however, eggs collected from the Delaware River were not sufficient to meet the goals for stocking larvae in the Delaware River Basin. Larvae were stocked in the Lehigh River (348 thousand), the Schuylkill River (380 thousand). No larvae were stocked in the Delaware River.

TETRACYCLINE MARKING

All American shad larvae stocked received marks produced by immersion in tetracycline (Table 6). Immersion marks for American shad were administered by 4h bath treatments in 256-ppm.

All American shad larvae were marked according to stocking site and/or egg source (Table 6). Some 1.2 million larvae received marks on days 3,6,12,15,18 and 21 and were stocked in the Juniata and Susquehanna Rivers. This mark was used in 2010 only and is the last year of a five year program to develop a reference collection of known age specimens. Some 1.3 million larvae received marks on day 3 and were also stocked in the Juniata or middle Susquehanna Rivers. Some 796 thousand larvae were marked on days 3,6 and 9 and stocked in the Juniata or middle Susquehanna Rivers. The North Branch Susquehanna River in Pennsylvania received 115 thousand larvae, marked on days 3,6, 9, and 15. The West Branch Susquehanna River received 400 thousand larvae marked on days 3,6,9,12, and15. Bald Eagle Creek, a tributary to the West Branch,

received 100 thousand larvae marked on days 3,6,9,12, and15 . Conodoguinnet Creek received 186 thousand larvae marked on days 3,6,12, and15. The Conestoga River received 217 thousand larvae marked on days 3,9,12, and15. Swatara Creek received 198 thousand larvae marked on days 3,6,9,15, and18. West Conewago Creek received 179 thousand larvae marked on days 3,9,12, 15, and18. The Lehigh River received 348 thousand larvae marked on days 9,12,15. The Schuylkill River received 380 thousand larvae marked on days 3,6,9,12.

Verification of mark retention was accomplished by stocking groups of marked fry in raceways at the Benner Spring State Fish Hatchery and examining otolith samples collected later. Otoliths were extracted and mounted in Permount on microscope slides. A thin section was produced by grinding the otolith on both sides. Otolith sections were examined for marks with an epi-fluorescent microscope with a UV light source.

All fish examined exhibited marks; however, observed marks did not necessarily conform to the marking protocol (Table 6). Digital photographs have been archived from representative samples of the marks detected for future reference. These will assist in identifying the origin of marks detected in out-migrating juveniles and returning adults from the 2010 cohort.

Groups that did not survive raceway culture included: Juniata/middle Susquehanna (3); Lehigh River (9,12,15); and Schuylkill river (3,6,9,12). The lack of survival for some raceway sections is unexplained.

The relatively large number of incorrect marks is likely due to faint marking produced as a result of higher than usual hardness. This was caused by the operation of the fluidized bed which not only increased the pH to more desirable levels but also

increased hardness. Increased hardness is known to reduce the intensity of OTC marks (Lucchesi 1999)). In addition, our UV scope is now 25 years old and obsolete. We experienced problems with burning out bulbs and seeing clear images. Observations with the UV scope at the Northeast Fishery Center at Lamar were made on some specimens and OTC marks were much brighter and more distinct.

SUMMARY

A total of 34 shipments of American shad eggs (30 million eggs) was received at Van Dyke in 2010. Total egg viability was 32% and survival of viable eggs to stocking was 67%, resulting in production of 5.5 million larvae. Larvae were stocked in the Juniata River (2.9 million), the West Branch Susquehanna River (400 thousand), the North Branch Susquehanna River in Pennsylvania (115 thousand), Conodoguinet Creek (186 thousand), Conestoga River (217 thousand), Swatara Creek (198 thousand), and West Conewago Creek (179 thousand). Delaware River source larvae were stocked in the Lehigh River (348 thousand), and the Schuylkill River (380 thousand). No larvae were stocked in the Delaware River because our stocking goals in the Lehigh and Schuylkill Rivers were not met.

Overall survival of larvae was 67%. No major mortality occurred due to disruption of flow. Installation of a fluidized bed system in 2008 and closer monitoring of the oxygen injection system resulted in pH and gas saturation levels that contributed to high survival.

All American shad larvae cultured at Van Dyke were marked by 4-hour immersion in oxytetracycline. Marks for American shad were assigned based on release site and/or egg source river. All raceway cultured shad examined for marks had marks, however

many had marks that were not intended. We attribute this to higher hardness associated with the use of the fluidized bed and failing UV microscopy equipment.

RECOMMENDATIONS FOR 2011

1. Disinfect all egg shipments at 50 ppm free iodine.
2. Slow temper eggs collected at river temperatures below 55°F.
3. Routinely feed all larvae beginning at hatch.
4. Continue to hold egg jars on the incubation battery until eggs begin hatching (usually day 7), before transferring to the tanks. Transfer incubation jars to the tanks on day 7 without sunning. Sun the eggs on day 8 to force hatching.
5. Continue to siphon eggshells from the rearing tank within hours of egg hatch.
6. Continue to feed left over AP-100 only if freshly manufactured supplies run out.
7. Use MSXXX jars preferentially to promote egg layering and maintain good egg survival.
8. Continue to collect American shad eggs from the Potomac River as an additional source of out-of-basin eggs.
9. Mark hickory shad at 512ppm OTC.
10. Continue using Pfizer Terramycin 343 or new generic equivalent PENNOX 343 (now FDA approved) for marking alosines.
11. Continue to utilize a fluidized bed system, using limestone sand to buffer the Van Dyke source water, neutralize the pH and reduce dissolved aluminum.
12. Continue to record pH, hardness and alkalinity on a regular basis to monitor fish culture water quality.

13. Continue to utilize additional packed column de-gassers to reduce the need for oxygen injection.
14. Continue to measure and record oxygen and nitrogen saturation on a daily basis. Use the oxygen injection system only when needed and monitor oxygen saturation and larval condition when the system is in use.
15. Mark all tanks of larvae beginning at 11:00AM, to ensure consistency in daily mark application.
16. Consider other options for hickory shad restoration, including direct stocking of eggs or stocking of pre-spawn adults, based on the absence of adult hickory shad in extensive collections conducted at the release sites in 2009 and 2010 by the Philadelphia Water Department.
17. Investigate the potential of increasing egg production at Conowingo Dam by constructing a new tank-spawn facility with the capability of controlling temperatures in order to tank-spawn without the use of hormone injections.
18. Rear raceway cultured juvenile shad in warming pond water regardless of pH.
19. Increase the concentration of OTC used for marking American shad from 256mg/L to 427mg/L to insure 100% marking.
20. Obtain permission to use the UV microscope at the Northeast Fishery Center in Lamar to view critical otolith specimens.

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Figure 1. American shad eggs incubated at Van Dyke, 1985-2010.

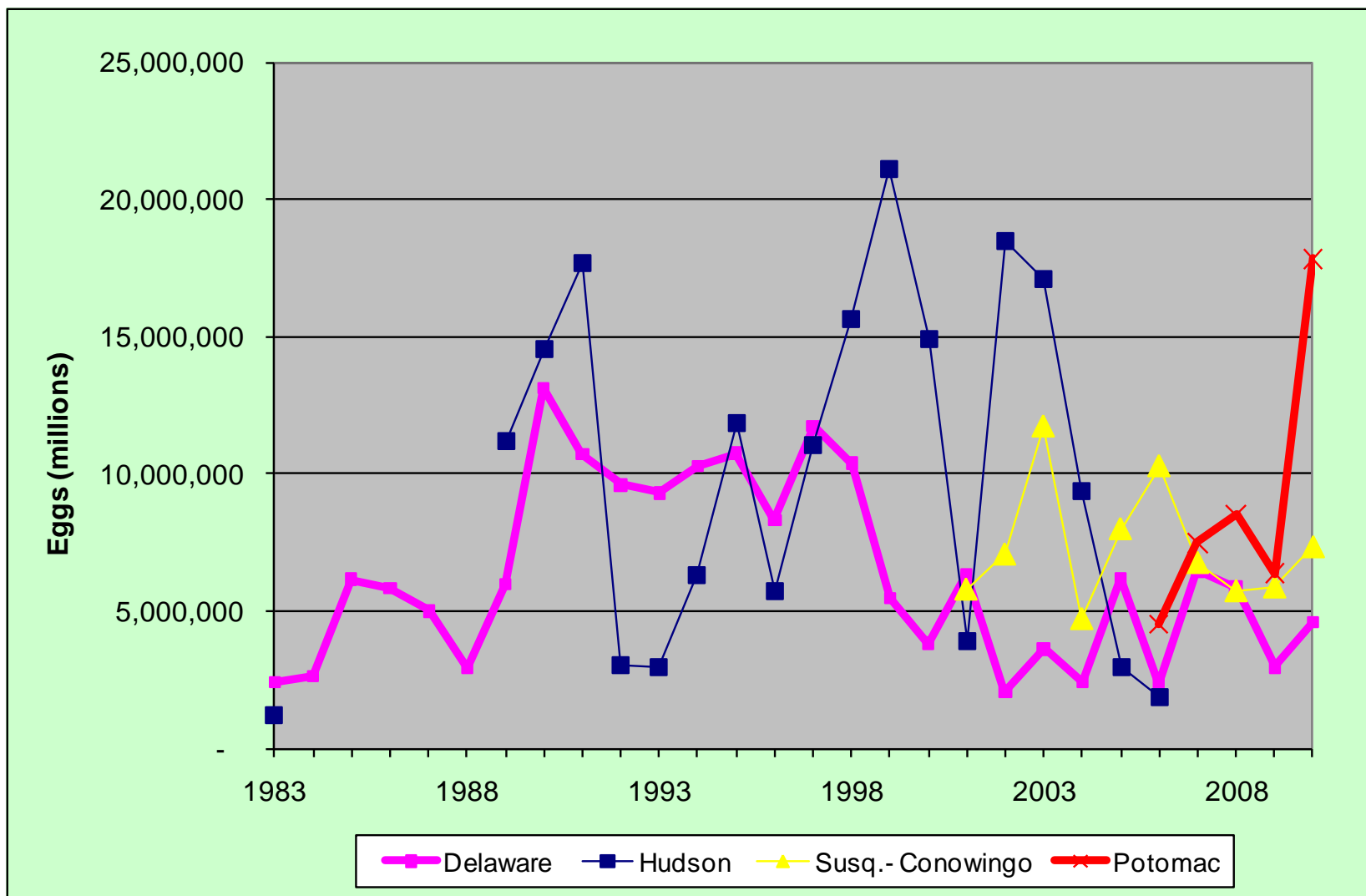


Table 1. Egg shipments received at Van Dyke, 2010.

No.	Species	River	Date Spawned	Date Received	Volume (L)	Eggs	Viable Eggs	Percent Viable
1	American Shad	Potomac	4/9/10	4/10/10	3.5	198,170	-	0.0%
2	American Shad	Potomac	4/11/10	4/12/10	13.6	689,748	331,970	48.1%
3	American Shad	Potomac	4/12/10	4/13/10	16.8	1,012,471	480,246	47.4%
4	American Shad	Potomac	4/13/10	4/14/10	10.3	397,262	166,230	41.8%
5	American Shad	Potomac	4/15/10	4/16/10	21.0	987,390	388,670	39.4%
6	American Shad	Potomac	4/18/10	4/19/10	15.7	629,562	327,931	52.1%
7	American Shad	Potomac	4/19/10	4/20/10	37.6	1,524,506	540,165	35.4%
8	American Shad	Potomac	4/20/10	4/21/10	51.1	2,158,133	448,560	20.8%
9	American Shad	Potomac	4/21/10	4/22/10	48.5	2,193,184	770,636	35.1%
10	American Shad	Potomac	4/22/10	4/23/10	18.0	868,013	416,935	48.0%
11	American shad	Susquehanna	4/24/10	4/25/10	16.2	637,702	227,501	35.7%
12	American shad	Potomac	4/25/10	4/26/10	25.7	1,336,606	578,966	43.3%
13	American Shad	Potomac	4/27/10	4/28/10	29.9	1,282,783	381,766	29.8%
14	American shad	Susquehanna	4/27/10	4/28/10	9.6	477,837	71,797	15.0%
15	American Shad	Potomac	4/28/10	4/29/10	9.7	377,964	133,149	35.2%
16	American Shad	Potomac	4/29/10	4/30/10	12.8	551,401	321,310	58.3%
17	American Shad	Susquehanna	5/1/10	5/1/10	14.1	900,598	77,070	8.6%
18	American Shad	Potomac	5/2/10	5/3/10	10.2	502,942	-	0.0%
19	American Shad	Potomac	5/4/10	5/5/10	41.3	2,338,403	1,212,945	51.9%
20	American Shad	Potomac	5/5/10	5/6/10	9.3	794,895	297,207	37.4%
21	American Shad	Susquehanna	5/6/10	5/6/10	11.3	899,169	30,810	3.4%
22	American Shad	Susquehanna	5/9/10	5/9/10	16.1	1,190,836	211,474	17.8%
23	American Shad	Susquehanna	5/12/10	5/12/10	17.1	1,309,110	273,517	20.9%
24	American Shad	Susquehanna	5/16/10	5/16/10	15.4	837,397	75,576	9.0%
25	American Shad	Delaware	5/16/10	5/17/10	16.5	675,010	276,029	40.9%
26	American Shad	Delaware	5/17/10	5/18/10	12.3	612,229	324,991	53.1%
27	American Shad	Susquehanna	5/21/10	5/21/10	15.5	1,091,853	155,486	14.2%
28	American Shad	Delaware	5/20/10	5/21/10	23.3	981,793	454,229	46.3%
29	American Shad	Delaware	5/23/10	5/24/10	2.8	124,225	43,257	34.8%
30	American Shad	Delaware	5/24/10	5/25/10	10.9	683,664	294,961	43.1%
31	American Shad	Delaware	5/25/10	5/26/10	6.7	539,502	181,615	33.7%
32	American Shad	Delaware	5/26/10	5/27/10	8.4	675,442	160,099	23.7%
33	American Shad	Delaware	5/27/10	5/28/10	2.5	168,617	-	0.0%
34	American Shad	Delaware	5/31/10	6/1/10	2.2	172,259	4,253	2.5%
Totals		No. of shipments						
	American shad	Potomac	17		375.0	17,843,432	6,796,685	38.1%
		Delaware	9		85.6	4,632,740	1,739,433	37.5%
		Susq.- Conowingo	8		115.3	7,344,503	1,334,705	15.6%
		Grand total	34		575.9	29,820,674	9,870,823	31.8%

Table 2. Annual summary of American shad production, 1976-2010.

Year	Egg Vol. (L)	No. of Eggs (exp.6)	Egg Viability (%)	No. of Viable Eggs (exp.6)	No. of Fry stocked (exp.3)	No. of Finglerling stocked (exp.3)	Total stocked (exp.3)	Fish Stocked/ Eggs Rec'd	Fish Stocked/ Viable Eggs
1976	120	4.0	52.0	2.1	518	266	784	0.19	0.37
1977	145	6.4	46.7	2.9	969	35	1,003	0.16	0.34
1978	381	14.5	44.0	6.4	2,124	6	2,130	0.10	0.33
1979	164	6.4	41.4	2.6	629	34	664	0.10	0.25
1980	347	12.6	65.6	8.2	3,526	5	3,531	0.28	0.43
1981	286	11.6	44.9	5.2	2,030	24	2,053	0.18	0.39
1982	624	25.9	35.7	9.2	5,019	41	5,060	0.20	0.55
1983	938	34.5	55.6	19.2	4,048	98	4,146	0.12	0.22
1984	1157	41.1	45.2	18.6	11,996	30	12,026	-	0.73
1985	814	25.6	40.9	10.1	6,960	115	7,075	0.28	0.68
1986	1535	52.7	40.7	21.4	15,876	61	15,928	0.30	0.74
1987	974	33.0	40.7	15.8	10,274	81	10,355	0.31	0.66
1988	885	31.8	38.7	12.3	10,441	74	10,515	0.33	0.86
1989	1220	42.7	60.1	25.7	22,267	60	22,327	0.52	0.87
1990	896	28.6	56.7	16.2	12,034	253	12,287	0.43	0.76
1991	902	29.8	60.7	18.1	12,963	233	13,196	0.44	0.73
1992	532	18.5	68.3	12.6	4,645	34	4,679	0.25	0.37
1993	558	21.5	58.3	12.8	7,870	79	7,949	0.37	0.62
1994	551	21.2	45.9	9.7	7,720	* 140	7,860	0.31	0.68
1995	768	22.6	53.9	12.2	10,930	* -	10,930	0.43	0.79
1996	460	14.4	62.7	9.0	8,466	* -	8,466	0.59	0.94
1997	593	22.8	46.6	10.6	8,019	25	8,044	0.35	0.76
1998	628	27.7	57.4	15.9	11,757	2	11,759	0.42	0.74
1999	700	26.6	59.2	15.7	14,412	-	14,412	0.54	0.92
2000	503	18.7	64.8	12.1	10,535	-	10,535	0.56	0.87
2001	423	21.1	35.0	7.4	6,524	7	6,531	0.31	0.88
2002	943	35.6	38.8	13.8	2,589	-	2,589	0.07	0.19
2003	1005	33.0	49.4	16.3	12,742	-	12,742	0.39	0.78
2004	462	17.3	54.0	9.3	5,637	-	5,637	0.33	0.60
2005	372	17.1	36.6	6.0	5,208	1	5,209	0.30	0.87
2006	394	19.0	35.2	6.7	4,945	-	4,945	0.26	0.74
2007	404	20.7	27.7	5.8	2,509	-	2,509	0.12	0.43
2008	441	20.1	28.3	5.7	4,020	-	4,020	0.20	0.71
2009	282	15.2	25.2	3.8	3,073	-	3,073	0.20	0.81
2010	576	29.8	31.8	9.9	5,471	3	5,474	0.18	0.55

*Includes fry reared at Manning Hatchery.

Total 260,441
Total since 1985 (OTC marked) 229,044

Table 3. American shad eggs used in Pennsylvania's shad restoration program, by egg source.

Year	Hudson Gill Net	Delaware Gill Net	Susquehanna Conowingo Tank Spawn	Susquehanna Lapidum Gill Net	Susquehanna Muddy Run Gill Net	Susquehanna Lamar Tank Spawn	Connecticut Gill Net	Pamunkey Gill Net	Mattaponi Gill Net	James Gill Net	Savannah Gill Net	Columbia Gill Net	Potomac Gill Net	Total
1971				8.42										8.42
1972				7.10										7.10
1973				4.74			4.30	8.45	6.48				34.64	58.61
1974							0.53	9.75	6.80	19.20		8.18	5.56	50.02
1975								1.88		7.15		18.42	5.70	33.15
1976		4.10										54.80		58.90
1977							0.35	4.40	0.57	3.42		8.90		17.64
1978								6.90		10.11		0.00		17.01
1979								3.17		4.99		0.00		8.16
1980								6.73		6.83		0.00		13.56
1981								4.58		1.26		5.78		11.62
1982								2.03		1.25		22.57		25.85
1983	1.17	2.40						5.49		5.91		19.51		34.48
1984		2.64						9.83		0.74		27.88		41.09
1985		6.16						5.28		2.05		12.06		25.55
1986		5.86						5.62		1.07		39.97		52.52
1987		5.01						4.35		0.11		23.53		33.00
1988		2.91						1.92		0.05		26.92		31.79
1989	11.18	5.96						1.91		0.53		23.10		42.68
1990	14.53	13.15				0.33		0.48			0.12			28.61
1991	17.66	10.75				0.30	1.10							29.80
1992	3.00	9.60					5.71			0.17				18.49
1993	2.97	9.30					7.45	1.78						21.50
1994	6.29	10.27					4.09	0.53	0.03					21.22
1995	11.85	10.75												22.61
1996	5.69	8.31				0.41								14.41
1997	11.08	11.76												22.84
1998	15.68	10.38				1.66								27.72
1999	21.10	5.49												26.59
2000	14.88	3.83												18.71
2001	3.92	6.35	5.81											21.13
2002	18.51	2.04	7.08			7.99								35.62
2003	17.12	3.61	11.72	0.56	0.02									33.04
2004	9.39	2.41	4.74	0.75										17.29
2005	2.92	6.21	8.00										0.00	17.14
2006	1.86	2.33	10.28										4.51	18.98
2007	0.00	6.46	6.77										7.49	20.72
2008		5.87	5.75										8.50	20.12
2009		2.96	5.89										6.38	15.23
2010		4.63	7.34										17.84	29.82
Total	190.81	181.51	73.38	21.57	0.02	15.74	23.53	85.08	13.88	64.84	0.12	291.62	90.63	1,052.73

Table 4. American shad stocking, 2010.

Date	Tank	Number	Location	OTC mark (days)	Origin	Age	Size
5/27/2010	B1	1 212,669	Juniata/Susq. R.	3,6,12,15,18,21	Potomac	37	Fry
5/21/2010	B2	1 401,113	Juniata/Susq. R.	3,6,12,15,18,21	Potomac	31	Fry
5/24/2010	B3	1 131,271	Juniata/Susq. R.	3,6,12,15,18,21	Potomac	34	Fry
5/27/2010	B4	1 229,424	Juniata/Susq. R.	3,6,12,15,18,21	Potomac	34	Fry
5/28/2010	C1	1 128,352	Juniata/Susq. R.	3,6,12,15,18,21	Potomac	36	Fry
5/21/2010	C2	1 133,401	West Branch Susq. R.	3,6,9,12,15	Potomac	23	Fry
5/21/2010	C3	1 266,695	West Branch Susq. R.	3,6,9,12,15	Potomac	23	Fry
5/24/2010	C4	1 78,926	North Branch Susq. R. (PA)	3,6,9,15	Potomac	25	Fry
5/24/2010	D1	1 35,736	North Branch Susq. R. (PA)	3,6,9,15	Potomac	25	Fry
5/28/2010	D2	1 116,261	Juniata/Susq. R.	3,6,12,15,18,21	Potomac	29	Fry
5/25/2010	D3	1 198,469	Swatara Creek	3,6,9,15,18	Potomac	26	Fry
5/25/2010	D4	1 216,988	Conestoga River	3,9,12,15	Potomac	26	Fry
5/28/2010	E1	1 193,671	Juniata/Susq. R.	3	Potomac	28	Fry
5/26/2010	E2	1 185,563	Conodoguinet Creek	3,6,12,15	Potomac	27	Fry
5/26/2010	E3	1 178,932	West Conewago Creek	3,9,12,15,18	Potomac	27	Fry
5/28/2010	E4	1 170,633	Juniata/Susq. R.	3,6,9	Susquehanna	25	Fry
5/28/2010	F1	1 196,948	Juniata/Susq. R.	3	Potomac	25	Fry
6/1/2010	F2	1 244,025	Juniata/Susq. R.	3	Potomac	29	Fry
6/1/2010	F3	1 122,853	Juniata/Susq. R.	3	Potomac	21	Fry
6/2/2010	F4	1 64,905	Juniata/Susq. R.	3	Potomac	27	Fry
6/2/2010	G1	1 32,570	Juniata/Susq. R.	3,6,9	Susquehanna	27	Fry
6/2/2010	G2	1 57,542	Juniata/Susq. R.	3	Potomac	26	Fry
6/2/2010	G3	1 203,791	Juniata/Susq. R.	3	Potomac	25	Fry
6/2/2010	G4	1 100,000	Juniata/Susq. R.	3,6,9	Susquehanna	24	Fry
6/2/2010	H2	1 250,000	Juniata/Susq. R.	3	Potomac	20	Fry
6/11/2010	H3	1 100,000	Bald Eagle Creek	3,6,9,12,15	Potomac	29	Fry
6/2/2010	I1	1 50,000	Juniata/Susq. R.	3,6,9	Susquehanna	20	Fry
6/2/2010	I2	1 147,356	Juniata/Susq. R.	3,6,9	Susquehanna	19	Fry
6/3/2010	I3	1 75,000	Juniata/Susq. R.	3,6,9,10	Susquehanna	15	Fry
6/3/2010	I4	1 100,000	Juniata/Susq. R.	3,6,9	Susquehanna	10	Fry
6/14/2010	A1	2 100,000	Lehigh R.	9,12,15	Delaware	21	Fry
6/14/2010	A2	2 100,000	Lehigh R.	9,12,15	Delaware	20	Fry
6/10/2010	A3	2 120,266	Juniata/Susq. R.	3,6,9	Susquehanna	14	Fry
6/14/2010	A4	2 97,522	Lehigh R.	9,12,15	Delaware	17	Fry
6/14/2010	B2	2 50,000	Lehigh R.	9,12,15	Delaware	17	Fry
6/16/2010	B3	2 180,000	Schuylkill R.	3,6,9,12	Delaware	14	Fry
6/16/2010	B4	2 100,000	Schuylkill R.	3,6,9,12	Delaware	13	Fry
6/16/2010	C2	2 100,000	Schuylkill R.	3,6,9,12	Delaware	13	Fry
10/22/2010		2,500	Juniata R.	various immersion tags + single feed tag	Various		Fing.

Table 5. Summary of stocking of juvenile Alosines from the Van Dyke Hatchery, 2010.

Site	Fry	Fing.
American shad Releases		
Millerstown (Greenwood)	10,000	
Millerstown (Rt. 17 Bridge)	2,776,291	
Arch Rock		2,500
Mifflin	120,266	
Juniata River Subtotal	2,906,557	
Clemson Island		
Montgomery Ferry		
Millersburg Ferry		
Liverpool	442,093	
Mahantango		
Conodoguinet Creek	185,563	
Conestoga River	216,988	
Swatara Creek	198,469	
West Conewago Creek	178,932	
North Branch Susquehanna River (PA)	114,662	
West Banch Susquehanna River	400,096	
Bald Eagle Creek	100,000	
Susquehanna River Basin Subtotal	4,743,360	2,500
Delaware River	-	
Schuylkill River	380,000	
Lehigh River	347,522	
Nanticoke River	-	
Potomac River	-	
Raritan River	-	
Total American shad	5,470,882	2,500

Table 6. Summary of marked Alosines stocked in Pennsylvania, 2010.

Table 6. Summary of marked Alosines stocked in Pennsylvania, 2010.										
Number	Size	Immersion mark (days)	Stocking Location	Egg Source	Immersion mark	Immersion Mark Retention (%)	Feed Mark	Feed Mark Retention (%)	Fry Culture	Fingerling Culture
American shad										
1,219,089	Fry	3,6,12,15,18,21	Juniata/Susquehanna	Potomac	256ppm OTC	83% ^a	-	-	Van Dyke	-
1,333,735	Fry	3	Juniata/Susquehanna	Potomac	256ppm OTC	NS	-	-	Van Dyke	-
795,826	Fry	3,6,9	Juniata/Susquehanna	Susquehanna	256ppm OTC	94% ^b	-	-	Van Dyke	-
114,662	Fry	3,6,9,15	N. Br. Susq. R.(PA)	Potomac	256ppm OTC	29% ^c	-	-	Van Dyke	-
400,096	Fry	3,6,9,12,15	W. Br. Susq. R.	Potomac	256ppm OTC	85% ^d	-	-	Van Dyke	-
100,000	Fry	3,6,9,12,15	Bald Eagle Creek	Potomac	256ppm OTC	see above	-	-	Van Dyke	-
185,563	Fry	3,6,12,15	Conodoguinet Creek	Potomac	256ppm OTC	77% ^e	-	-	Van Dyke	-
216,988	Fry	3,9,12,15	Conestoga River	Potomac	256ppm OTC	91% ^f	-	-	Van Dyke	-
198,469	Fry	3,6,9,15,18	Swatara Creek	Potomac	256ppm OTC	100%	-	-	Van Dyke	-
178,932	Fry	3,9,12,15,18	West Conewago Creek	Potomac	256ppm OTC	100%	-	-	Van Dyke	-
347,522	Fry	9,12,15	Lehigh R.	Delaware	256ppm OTC	NS	-	-	Van Dyke	-
380,000	Fry	3,6,9,12	Schuylkill R.	Delaware	256ppm OTC	NS	-	-	Van Dyke	-
2,500	Fing.	various	Juniata	various	256ppm OTC		single	15% ^g	Van Dyke	Benner Spring
^a 2 specimens (17%) missing the day 21 mark										
^b 1 specimen (6%) missing the day 3 mark										
^c 9 specimens (64%) exhibited marks on days 3,6,9,12; 1 specimen (7%) exhibited marks on days 3,6,9										
^d 3 specimens (15%) exhibited marks on days 3,6,9,12										
^e 1 specimen exhibited marks on days 3,6,9,12; 1 specimen exhibited marks on days 3,9,12,15; 1 specimen exhibited marks on days 3,6,9,12,15										
^f One specimen (5%) exhibited marks on days 3,6,9,12,15; one specimen (5%) exhibited marks on days 3,9,12,15,18										
^g Most of the specimens viewed exhibited rough edges making detection of the mark impossible.										
NS = did not survive raceway culture or were never stocked in the raceway										